Proposal of action plan to support energy efficiency policies regarding the conservation of energy resources in Brazil
Proposal of action plan to support energy efficiency policies regarding the conservation of energy resources in Brazil

This work was written as a result of the group and region-focused training “Energy-Saving Technology and Governmental Promotion (J15-04105)” of the Japan International Cooperation Agency (JICA), which was implemented as part of the Official Development Assistance of the Government of Japan and took place in Japan from August 23rd to September 19th, 2015.
To Paula and Laura
“Transport contributes almost one-quarter (23 percent) of the current global energy-related greenhouse gas (GHG) emissions and is growing faster than any other energy end-use sector. GHG emissions from transport are anticipated to rise from today’s levels by nearly 20 percent by 2030 and close to 50 percent by year 2050 unless major action is undertaken.

Limiting the global temperature increase to below 2 degrees Celsius requires changing this transport emissions trajectory, which involves the development of an integrated electromobility ecosystem encompassing various transport modes, coupled with the low-carbon production of electricity and hydrogen, implemented in conjunction with broader sustainable transport principles.

According to the International Energy Agency, this transition will require, inter alia, pursuit of global rail transport electrification, already underway, as well as at least 20 percent of all road transport vehicles globally to be electrically driven by 2030 – if warming is to be limited to 2 degrees or less. Of this, light vehicles would primarily contribute: more than 400 million two and three-wheelers in 2030, up from roughly 230 million today; and more than 100 million cars in 2030, up from 1 million today.

To achieve this goal IEA modelling says electric drive vehicles (battery-electric, plug-in hybrid, and fuel cell vehicles, including two and three wheelers, cars, light commercial vans, buses, trucks and others) need to represent 35 percent of global sales in 2030.”

Paris Declaration on Electro-Mobility and Climate Change & Call to Action
ABSTRACT
This paper aims to draw up a proposal of an action plan to support energy efficiency policies regarding the conservation of energy resources in Brazil. Considering the natural resources available in the country and the share of the transportation sector in energy consumption, as well as in air pollution and greenhouse gas emissions, the intention here is to present the advantages related to the energy efficiency of the electric vehicles in comparison with the conventional internal combustion vehicles. Thus, focused on corporate and official fleets, as well as public transportation, tax burden relief or exemption could be used as an initial strategy to accelerate the acquisition of electric vehicles and disseminate environmentally friendly technologies that could replace fossil fuels powered transportation.

RESUMO
Este trabalho tem como objetivo elaborar uma proposta de plano de ação para apoiar políticas de eficiência energética relativas à conservação de recursos energéticos no Brasil. Considerando os recursos naturais disponíveis no país e a participação do setor de transporte no consumo de energia, bem como na emissão de poluentes e gases de efeito estufa, a intenção aqui é apresentar as vantagens relacionadas com a eficiência energética dos veículos elétricos em comparação aos veículos convencionais movidos a combustão interna. Assim, com foco na frota de veículos corporativos e oficiais, e também nos meios de transporte público, o alívio ou a isenção da carga tributária poderia ser usado como uma estratégia inicial para se acelerar a aquisição de veículos elétricos e disseminar tecnologias ambientalmente amigáveis que pudessem substituir o transporte movido por meio de combustíveis fósseis.
LIST OF TABLES

Table 1 – National energy matrix…………………………………………………………………..……………2
Table 2 – Vehicles manufactures in Brazil…………………………………………………………………..14
Table 3 – Brazilian vehicles fleet…………………………………………………………………..……………15
Table 4 – Market share of electric car sales in 2015………………………………………………………23
Table 5 – Electric car stock in 2015…………………………………………………………………..……………24
Table 6 – Hybrid and electric vehicles commercialized in Brazil in 2015………………………………25
Table 7 – Taxes on vehicles and wheel tractors…………………………………………………………………..26
Table 8 – Brazilian automotive industry trade balance in 2014…………………………………………..27

LIST OF FIGURES

Figure 1 – Balance between supply sources and energy consumption………………………………5
Figure 2 – Balance between supply sources and electric energy consumption…………………...6
Figure 3 – Brazil estimates of greenhouse gases emissions share in 2014…………………………10
Figure 4 – Air pollution over the City of São Paulo……………………………………………………12
Figure 5 – São Paulo estimates of greenhouse gases emissions share in 2014…………………12
Figure 6 – Vehicle production by continent in 2014………………………………………………………….16
Figure 7 – Cars and motorcycles per capita in Brazilian Municipalities………………………….17
Figure 8 – Efficiency gains in countries with supply based on thermoelectric plants……………21
Figure 9 – Efficiency gains in countries with supply based on hydro plants…………………22
LIST OF GRAPHICS

Graphic 1 – Projection of the total energy demand until 2050..................................................3
Graphic 2 – Share of energy sources in 2014.............................................................................3
Graphic 3 – Share of electric energy sources in 2014.................................................................4
Graphic 4 – Share of energy consumption in 2014.....................................................................4
Graphic 5 – Share of electric energy consumption in 2014.........................................................5
Graphic 6 – Energy efficiency gains by sector in the long-term horizon.................................7
Graphic 7 – Energy efficiency share by sector in the long-term horizon.................................7
Graphic 8 – Energy efficiency aggregate indicators: energy and electric intensity.............8
Graphic 9 – Consumption per capita of electric energy (kWh/capita).......................................9
Graphic 10 – Share of greenhouse gas emissions by major segments....................................10
Graphic 11 – Share of greenhouse gas emissions by major segments....................................11
Graphic 12 – Vehicle production in Brazil..................................................................................13
Graphic 13 – Biggest vehicle fleets in the world in 2014.........................................................15
Graphic 14 – Biggest vehicle producers in the world in 2014....................................................15
Graphic 15 – Vehicles per capita...............................................................................................16
Graphic 16 – Comparison of the transport modals for selected countries..............................18
Graphic 17 – Projection of new vehicles licensing in Brazil until 2050.....................................19
Graphic 18 – Projection of cars fleet by energy source until 2050.............................................20
Graphic 19 – Consumption by energy source in transportation sector until 2050.............20
Graphic 20 – Rise of electric cars stock and annual sales.........................................................25
Graphic 21 – Tax burden on cars - Share in consumer prices - 2014........................................26
Graphic 22 – Net revenue from 1966 to 2013..........................................................................27
**CONTENTS**

1. Introduction .......................................................................................................................... 1
2. Energy Generation and Consumption in Brazil .................................................................. 1
3. Energy Efficiency and Energy Conservation Projections ............................................. 6
5. Brazilian Automotive Industry ......................................................................................... 12
6. Perspectives about Electrical Vehicles and Action Plan .................................................. 17
7. Conclusion .......................................................................................................................... 29
1 Introduction

This paper aims to draw up a proposal of an action plan to support energy efficiency policies regarding the conservation of energy resources in Brazil. More specifically, the intention here is to present the advantages related to the promotion and dissemination of plug-in electric vehicles in replacement of the conventional internal combustion vehicles.

As will be seen in the sequence, the transportation sector is one of the largest consumers of energy resources in the country, besides being a major emitter of greenhouse gases and air pollutants. Their participation in efficiency actions, thus, has great potential to reduce the growth rate of energy demand as a whole, as well as contribute to a sustainable and environmentally friendly economic model.

At first, we present an overview of the Brazilian energy balance, the main sources of generation, the activities that consume more energy, as well as the perspectives about energy efficiency gains in the long term. Later, we illustrate the estimates of greenhouse gas emissions, detailing the emissions share related to the energy sector.

In the following sections, we discuss the transportation sector in Brazil, notably the Brazilian industrial park, the growth of the vehicle fleet observed in recent decades, the existing initiatives to introduce electric vehicles in the country and the tax burden in the final value of vehicles to the consumers. Finally, we present a proposal that aims to increase the introduction of electric passenger cars in the market: the granting of tax relief or exemption to stimulate the gradual replacement of the corporate and official fleet in companies and public administration offices, as well as the adoption of electric solutions to power public transportation.

2 Energy Generation and Consumption in Brazil

Initially, it is important to point out some legal framework and the institutional players responsible for the energy sector, its planning and studies, reports and statistics elaboration in Brazil.

The Ministry of Mines and Energy – MME (Ministério de Minas e Energia – MME1) is responsible for formulating the basic principles and the guidelines of the national energy policy. To support its activities, MME promotes, through its related companies, various studies and analyzes, which aim the planning of the energy sector in Brazil.

Following the institutional changes in the energy sector over the past decades, in 2004 was created the Energy Research Company – EPE (Empresa de Pesquisa Energética – EPE2). EPE is a public company, set up pursuant to Law n. 10.847/2004, and Decree n. 5.184/2004. Its purpose is to provide services to support the planning of the energy

1 http://www.mme.gov.br/

2 http://www.epe.gov.br/
sector, mainly researching fields like electricity, natural gas, oil and its derivatives, coal, renewable energy sources and energy efficiency, among others. According to the Law, EPE has to prepare and publish the National Energy Balance – BEN (Balanço Energético Nacional – BEN).

The BEN annually documents and reports extensive research and accounting related to energy supply and consumption in Brazil, contemplating the activities of extraction of primary energy resources, conversion into secondary forms, import and export, distribution and end-use of energy.

According to the data available in Table 1 - National Energy Matrix (Matriz Energética Nacional\(^3\)), which subsidizes the information accessible in the BEN, we had in the year 2014 the following scenario of import, production and export of primary and secondary sources of energy.

<table>
<thead>
<tr>
<th>Source</th>
<th>Import</th>
<th>Production</th>
<th>Export</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil and its Products</td>
<td>42.877</td>
<td>116.543</td>
<td>-39.417</td>
<td>120.003</td>
</tr>
<tr>
<td>Natural gas</td>
<td>17.001</td>
<td>24.371</td>
<td>-</td>
<td>41.373</td>
</tr>
<tr>
<td>Coal and its Products</td>
<td>14.656</td>
<td>2.895</td>
<td>-</td>
<td>17.551</td>
</tr>
<tr>
<td>Wood and Charcoal</td>
<td>-</td>
<td>24.728</td>
<td>-</td>
<td>24.728</td>
</tr>
<tr>
<td>Uranium</td>
<td>2.769</td>
<td>1.266</td>
<td>-</td>
<td>4.036</td>
</tr>
<tr>
<td>Hidraulic and Electricity</td>
<td>2.904</td>
<td>32.116</td>
<td>-</td>
<td>35.019</td>
</tr>
<tr>
<td>Sugar Cane and its Products</td>
<td>-</td>
<td>48.128</td>
<td>-</td>
<td>48.128</td>
</tr>
<tr>
<td>Other Sources</td>
<td>-</td>
<td>14.427</td>
<td>-</td>
<td>14.427</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>80.208</strong></td>
<td><strong>264.474</strong></td>
<td><strong>-39.417</strong></td>
<td><strong>305.265</strong></td>
</tr>
</tbody>
</table>

* Source: Prepared by the author from EPE (Matriz Energética Nacional ab2014 – Excel)

We can see from the numbers above that most of the Brazilian needs of energy (86.64%) is produced in the country, being oil, sugar cane, natural gas and the hydraulic potentials the most representative sources of energy. Despite the large amount of oil production, it is not enough to supply the internal demand, being the import of oil and its products also large, representing about 53.46% of the imports.

Estimates conducted by EPE indicate that in the year 2050 the energy demand in Brazil is going to be almost twice the actual amount, with an average increase of 2.2% per anno. Graphic 1 below illustrates the projection of each source’s participation in the national matrix, year by year until 2050.

An outstanding feature of the Brazilian energy matrix is the high share of renewable energy sources. While the world average\(^4\) in 2012 was about 13%, in Brazil the share of renewable sources in 2014 was approximately 40%.

\(^{4}\)International Energy Agency (www.iea.org)
Much of that is due to the high production of biofuels (ethanol) from sugarcane. Another feature that also contributes to this result is the abundant hydroelectric potential in the country, which is the main primary source of energy in the electricity sector, which by the way also generates from the burning of the sugar cane bagasse after grinding process, both to biofuel and sugar production. Considering also other sources, like the winds and the sun, 74.6% of the electric energy comes from renewable sources.

**Graphic 3 – Share of electric energy sources in 2014**

On the demand side, the largest energy consumers are the industries (32.9%) and the transportation sector (32.5%), which account for over 65% of the energy consumption in Brazil. After the industries and the transportation sector, as most representative consumers come the energy sector (10.3%), the residential (9.3%), the commercial and services (4.7%) and the agriculture sector (4.2%).

**Graphic 4 – Share of energy consumption in 2014**

*Source: Prepared by the author from EPE (Síntese do Relatório Final 2015)*
Figure 1 below illustrates the balance between supply sources and energy consumption. We can clearly identify the greatest energy sources (sugar cane, oil and its products) also the largest consumers (industry and transport). Here the losses are considered separately on the demand side and are about 13%.

Specifically regarding the electric energy consumption, the largest consumers are the industries (37,8%), the households (27,8%) and the commercial and service sector (18,90%), which together account for 84,5% of the electricity consumption in Brazil. The transport sector is not a major consumer of electrical energy.

*Source: EPE (Síntese do Relatório Final 2015)*

*Figure 1 – Balance between supply sources and energy consumption*

*Graphic 5 – Share of electric energy consumption in 2014*

*Source: Prepared by the author from EPE (Síntese do Relatório Final 2015)*
Figure 2 below illustrates the balance between supply sources and the consumption of electricity. It can be clearly seen that the dams are in fact the major source of electricity, which accounts alone for 65.2% of the electricity generation. Here we consider the losses separately on the demand side, representing about 15% of energy consumption.

3 Energy Efficiency and Energy Conservation Projections

In projections of future demand, the improvement of the energy efficiency in supply as well as in consumption is of great importance and have to be considered seriously in the long-term planning.

As indicated in the Technical Note DEA 13/14, the National Energy Plan 2030 (PNE 2030) explains the importance and the role of the energy efficiency in national energy planning, also presenting for the first time, at a governmental level, the indication of a national target for energy efficiency.

In the long term, estimates indicate that the energy efficiency can contribute to approximately 20% of the total energy demand and about 18% of the electricity demand. According to these estimates, the energy efficiency measures will contribute to reduce the energy demand by approximately 138 million tons of oil equivalent in 2050. The efficiency gain amounts achieved by each sector are shown in Graphic 6.
In terms of sectoral contribution to energy efficiency gains, the sectors that will most contribute to those gains are the transportation and the industrial sectors, with a share of 43% for both (see Graphic 7 below). Estimates indicate that the entire industrial sector will reach, at the end of the horizon, energy efficiency gains over than 160 TWh, which is equivalent to 10% of the total electricity consumption projected for the year 2050.

Currently, a series of energy efficiency policies and programs are in progress in the fields of edification, agriculture, transportation and industry. Such policies and programs include tax incentives for new technologies, the provision of better information for consumers, investments in strategic areas and coercive measures such as the ban of the incandescent light bulbs.
If we consider the estimates for the aggregate indicators of energy efficiency, we have the energy intensity showing a slight increase between 2013 and 2020 and, after 2020, a decrease until 2050. The electric intensity also remains slightly increasing between 2013 and 2020, with a slight decrease after 2020.

Graphic 8 – Energy efficiency aggregate indicators: energy and electric intensity

*Source: Prepared by the author from EPE (Nota Técnica DEA 13/14 – Demanda de Energia 2050)

As highlighted in the Technical Note DEA 13/14, the energy intensity is more adherent as an indicator of energy productivity of the economy than as an energy efficiency indicator. However, this indicator appears to be quite interesting to follow the evolution of the "energy efficiency" level of the economy and allow us to make international comparisons.

Over the considered period, the population is going to increase at lower rates and, parallel to this, the income level of the population is going to increase. Because of this, the energy annual consumption per capita will increase from 1.21 toe in 2013 to 2.43 toe in 2050. Similarly, the annual per capita consumption of electricity will increase from 2.532 kWh in 2013 to 7.182 kWh in 2050.

Graphic 9 below illustrates the evolution of the consumption per capita of electricity, as well as the gross domestic product considering the purchasing power parity per capita. By way of comparison, Brazil is currently at a level similar to Mexico, China and South Africa. With the economic growth, Brazil is going to have a per capita consumption similar to developed countries only at the end of the period considered in the studies presented in the Technical Note DEA 13/14.
4 Greenhouse Gas Emissions Estimates

The importance that energy takes in people’s lives is unquestionable. From the most trivial daily activities to the most complex production processes, we need some source of energy to live. Our modern conception of wellness precludes the idea of a society without the facilities of all energy sources that we have today, be it electric, thermal, motive, chemical or any other kind.

The current level of human activities can be, however, one of the main causes of the climate changes observed in recent decades. Among these changes is the increase in average global temperature, which is directly influenced by emissions of greenhouse gases. Power generation from fossil fuels burning or the use of wasteful and unsustainable resources are relevant factors that should be considered in the mitigation of such problems. The way we generate energy, thus assumes a central role in this matter.

According to estimates made by “Sistema de Estimativa de Emissão de Gases de Efeito Estufa” (SEEG), the emissions in Brazil are classified into five major segments: energy, industrial processes, waste, land use change and agriculture. In Figure 3 below, we see that the emissions from energy sectors, land use change and agricultural are far greater than the emissions from industrial processes and waste. For sure, this picture varies accordingly with the different regions of the country, depending on the main economic activities of each State.

5 The “Sistema de Estimativas de Emissões de Gases de Efeito Estufa (SEEG)” is an initiative of the “Observatório do Clima” and comprises the production of annual estimates of greenhouse gases emissions in Brazil.
For the year 2014, the major segments energy (31%), agriculture (31%) and change of land use (27%) accounted for 89% of all emissions. Regarding only the economic activities, agriculture stands out, being greater than the sum of all other activities.
However, regarding the energy segment, we can see that the emissions from transport activities are the most significant. Energy demand in the transport activities is characterized by the predominance of road transport (91.6% of consumption in 2012) and the heavy dependence on oil (82.8% of consumption in 2012).

As indicate the estimates of recent years, the transport sector has the highest growth rates of energy consumption (4.42% per anno between 2002 and 2012). The CO2 emissions rose from 84 million tons in 1990 to 204 million in 2012.

In addition to environmental pollution and its correlation with global warming, emissions from the transportation sector are particularly harmful in large urban centers, being the cause of respiratory diseases also contributing to worse other diseases, affecting mainly elderly and children.

According to World Health Organization (WHO), 8 million people die each year due to pollution. In São Paulo, the State with the largest fleet of vehicles and the largest industrial park in Brazil, estimates indicate that 99,000 people died between 2006 and 2011 from respiratory or cardiovascular diseases linked to air pollution. In the State of Rio de Janeiro had been 36,000 deaths.

Figure 4 below gives an idea about the air pollution over the City of São Paulo when the climate conditions are not favorable. In addition, considering only the State of São Paulo, we can see how the transportation sector affects the emission estimates of this region of the country.

---

*Source: Prepared by the author from SEEG

[http://g1.globo.com/jornal-nacional/noticia/2015/06/oms-diz-que-poluicao-atmosferica-mata-oito-milhoes-de-pessoas-por-ano.html](http://g1.globo.com/jornal-nacional/noticia/2015/06/oms-diz-que-poluicao-atmosferica-mata-oito-milhoes-de-pessoas-por-ano.html)
Figure 4 – Air pollution over the City of São Paulo

*Source: Internet (Paulo Pinto/Public Photos)

Figure 5 – São Paulo estimates of greenhouse gases emissions share in 2014

*Source: http://plataforma.seeg.eco.br/sankey#

---

5 Brazilian Automotive Industry

The auto industry in Brazil begins in 1951, when President Getúlio Vargas ordered a feasibility study to establish a national automotive industry. At that same year, a commission traveled abroad in order to convince large manufacturers to invest in Brazil. In exchange, the investors would receive tax reductions and profit remittance to foreign headquarters guaranteed.

In 1953 was organized a big fair to show to the industry entrepreneurs the ability to produce auto parts in the country. In the same year, Volkswagen was the first automaker to be installed in Brazil, soon being followed by other companies. However, the production of vehicles between 1953 and 1956 was very low, and all factories produced far below their capacity⁸. As indicate the chart below, this picture starts to change from the following years on. Since 2008, the vehicle production is over 3 million units per anno and in 2013 was achieved a maximum of 3.738.448 units.

![Graphic 12 – Vehicle production in Brazil](image)

*Source: Prepared by the author from ANFAVEA Yearbook 2015

In 1956 was created ANFAVEA, which is the national association of the automobile manufacturers in Brazil. Currently ANFAVEA brings together 31 companies. In Table 2 below, we can see which of them are involved with the production of cars, light commercial vehicles, trucks and buses.

⁸ https://pt.wikipedia.org/wiki/Ind%C3%BAstria_automobil%C3%ADstica_no_Brasil
Table 2 – Vehicles manufactures in Brazil

<table>
<thead>
<tr>
<th>Empresas</th>
<th>PRODUTOS / PRODUCTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Automóveis</td>
</tr>
<tr>
<td>Agrale</td>
<td>🚗</td>
</tr>
<tr>
<td>BMW</td>
<td>🚗</td>
</tr>
<tr>
<td>CAOA</td>
<td>🚗</td>
</tr>
<tr>
<td>DAF</td>
<td>🚗</td>
</tr>
<tr>
<td>Fiat</td>
<td>🚗</td>
</tr>
<tr>
<td>Ford</td>
<td>🚗</td>
</tr>
<tr>
<td>General Motors</td>
<td>🚗</td>
</tr>
<tr>
<td>Honda</td>
<td>🚗</td>
</tr>
<tr>
<td>Hyundai</td>
<td>🚗</td>
</tr>
<tr>
<td>International</td>
<td>🚗</td>
</tr>
<tr>
<td>Iveco</td>
<td>🚗</td>
</tr>
<tr>
<td>Mahindra</td>
<td>🚗</td>
</tr>
<tr>
<td>MAN</td>
<td>🚗</td>
</tr>
<tr>
<td>Mercedes-Benz</td>
<td>🚗</td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>🚗</td>
</tr>
<tr>
<td>Nissan</td>
<td>🚗</td>
</tr>
<tr>
<td>Peugeot Citroën</td>
<td>🚗</td>
</tr>
<tr>
<td>Renault</td>
<td>🚗</td>
</tr>
<tr>
<td>Scania</td>
<td>🚗</td>
</tr>
<tr>
<td>Toyota</td>
<td>🚗</td>
</tr>
<tr>
<td>Volkswagen</td>
<td>🚗</td>
</tr>
<tr>
<td>Volvo</td>
<td>🚗</td>
</tr>
</tbody>
</table>

*Source: ANFAVEA Yearbook 2015

The 31 member companies of ANFAVEA have together 64 industrial units. The factories are based in 52 Municipalities of 10 States (Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Rio de Janeiro, Minas Gerais, Goiás, Bahia, Ceará and Amazonas). Across the country, there are currently 4.364 dealerships.

Table 3 below brings the Brazilian vehicle fleet estimated for the year 2014, according to ANFAVEA. The passenger cars represent 78% of the total fleet. Nevertheless, it is important to point out that those numbers do not include the motorcycles. According to motorcycles manufactures yearbook, the fleet of motorcycles in 2014 was about 23 million units, with an annual production of 1 million units.
Table 3 – Brazilian vehicles fleet

<table>
<thead>
<tr>
<th></th>
<th>Automóveis (Cars)</th>
<th>Comerciais leves (Light commercials)</th>
<th>Caminhões (Trucks)</th>
<th>Ônibus (Buses)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brasil / Brazil</td>
<td>32,715</td>
<td>6,287</td>
<td>2,100</td>
<td>640</td>
<td>41,743</td>
</tr>
</tbody>
</table>

*Source: ANFAVEA Yearbook 2015

Those numbers rank Brazil as the 8\textsuperscript{th} biggest fleet of vehicles in the world.

Considering the production of vehicles, Brazil is also in 8\textsuperscript{th} position.

*Source: Prepared by the author from ANFAVEA Yearbook 2015
The production of vehicles in Brazil represents 3,5% of the world total production.

**Figure 6 – Vehicle production by continent in 2014**

<table>
<thead>
<tr>
<th>Continent</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>22,7%</td>
</tr>
<tr>
<td>Asia</td>
<td>52,6%</td>
</tr>
<tr>
<td>America</td>
<td>23,7%</td>
</tr>
<tr>
<td>Oceania</td>
<td>0,2%</td>
</tr>
<tr>
<td>Others</td>
<td>3,5%</td>
</tr>
<tr>
<td>Brasil</td>
<td>0,8%</td>
</tr>
</tbody>
</table>

*Source: ANFAVEA Yearbook 2015

Those numbers may seem high, but if compared to the rate of motorization in other countries, we see that the number of vehicles per inhabitant in Brazil is still low and even in 2050 will be lower than those ones currently observed in developed countries.

**Graphic 15 – Vehicles per capita**

*Source: EPE (Nota Técnica DEA 13/14 – Demanda de Energia 2050)

It is also interesting to point out some differences among the wealthier and the poorest regions in Brazil. Most of the vehicle fleet is concentrated in the southern
parts of the country, while in the north and northeast parts of the country we have a higher concentration of motorcycles, which are obviously cheaper and more accessible to the population in those regions.

Figure 7 – Cars and motorcycles per capita in Brazilian Municipalities

*Source: http://g1.globo.com/carros/frota-carros-motos-2013/index.html

6 Perspectives about Electrical Vehicles and Action Plan

For Brazil, the energy efficiency, the waste of resources and the increase of the emissions in the transportation sector is more relevant. This is because the transport of goods and products in Brazil is predominantly made on roads and fossil fuels powered.

According to Technical Note 13/14 DE, a study conducted in 2002 by World Bank estimated that the logistic costs in Brazil represent approximately 20% of GDP, while for European and North American countries this percentage stands between 10 and 12%. In this same study, logistic costs due to transportation were estimated at about 32% (GUASCH, 2002, cited by the Ministry of Transport, 2012).

When we compare countries with similar territorial dimensions, the modal structure of the cargo transportation in Brazil really presents significant imbalance, with a
predominant participation of road transportation (see Graphic 16). This imputes higher freight costs than other alternatives like waterways and rails (FERRUPATO 2012, Ministry of Transport, 2012).

**Graphic 16 – Comparison of the transport modals for selected countries**

![Graphic 16](image)

*Source: Prepared by the author from EPE (Nota Técnica DEA 13/14 – Demanda de Energia 2050)

Considering what was mentioned before about the high consumption of fossil fuels in the transportation sector, the high level of greenhouse gas emissions, air pollution, related health problems as well as the low energy efficiency of fossil fuels powered engines, the electric vehicles are a feasible alternative to solve or at least attenuate many of those problems.

As indicated by (BARASSA, 2015):

“From the argument that the increasing use of oil in the world is due to automotive vehicles (FREYSSSENET, 2011), the electric vehicles stand out as an opportunity to break the dependency on fossil fuels.

Air pollution-related problems in urban centers also stimulated the recovery process of manufacturing electric vehicles. Vehicles powered by internal combustion engines are mainly responsible for air pollution in the cities because of the emission of particulate materials (ARBEX, 2012).

In the beginning of the twenty-first century, the argument that one of the main causes of death in the world comes from constant exposure to air pollutants was consolidated. According to the World Health Organization (WHO), approximately 7 million people died in 2012 due to exposure to air pollution, becoming worldwide the biggest environmental risk factor to health (WHO, 2015).” (Author translation)
At the United Nations Climate Change Conference, COP 21 and CMP 11, in 2015, the “Paris Declaration on Electro-Mobility and Climate Change & Call to Action” highlighted the importance of the electric vehicles, transportation and mobility in general; projecting the necessary amount of future adoption of electric vehicles in favor of fossil fuels powered ones.

“According to the International Energy Agency, this transition will require, inter alia, pursuit of global rail transport electrification, already underway, as well as at least 20 percent of all road transport vehicles globally to be electrically driven by 2030 – if warming is to be limited to 2 degrees or less. Of this, light vehicles would primarily contribute: more than 400 million two and three-wheelers in 2030, up from roughly 230 million today; and more than 100 million cars in 2030, up from 1 million today.”

In Brazil, according to Technical Note DEA 13/14, projections indicate that the licensing of passenger vehicles powered by internal combustion will continue until the year 2045, from when only vehicles powered by other technologies will be licensed. Estimates indicate that in the year 2050 the hybrid vehicles will represent 85% of new licensing, while 15% will be of electric vehicles. By the year 2050, approximately 40% of the fleet will be composed of internal combustion vehicles, being 60% of hybrid and electric vehicles.

In Graphic 17 below, we can see that the perspective about the substitution of the actual technology will be slow and gradual. Even 25 years from now, we will still have an automobile industry prevalently based on internal combustion engines.

Graphic 17 – Projection of new vehicles licensing in Brazil until 2050

*Source: EPE (Nota Técnica DEA 13/14 – Demanda de Energia 2050)
Throughout this period, the passenger vehicle fleet will triple, from the current 35 million to more than 124 million cars. This growth is consistent with the prospects for the economic growth and the fact that the motorization rate in Brazil is still small when compared with those ones observed in developed countries.

With the introduction of electric cars, the electricity consumption in the transportation sector will grow, reaching about 4 million m³ of gasoline equivalent, so far small in comparison with other energy sources such as diesel oil, gasoline and ethanol.
Despite those projections, many people still worry about the increase of electricity consumption and, consequently, about the investments necessary to meet the increasing demand of electric energy. As estimated\(^9\) by Electric-Mobility Department of Itaipu Binacional, even if all domestic production of vehicles was to become of electric vehicles overnight, the increase in electricity demand would be around 3,3\(^{\text{10}}\). Nevertheless, we also have to consider that the global gains in energy efficiency and the reduction of fossil fuel consumption will offset this increase.

According to Electric-Mobility Department of Itaipu Binacional, the total substitution of the domestic fleet would result in substantial efficiency gains. In Figure 8, for example, we have the estimates considering:

i) An electric supply based entirely on thermoelectric power plants; and

ii) The substitution of a diesel powered fleet in favor of an electric powered one.

In Brazil, the useful energy necessary to move the domestic fleet is equivalent to 1,3 Itaipus\(^{11}\). Considering the efficiency of diesel engines, we have along the whole process

---

\(^9\) Estimates consider the electricity consumption of 2011 (430 TWh), a production of 3,4 million cars/anno and an average consumption of 10 kWh/day for a daily route of 60 km.

\(^{10}\) Information obtained from the presentation done by Electric-Mobility Department of Itaipu Binacional, pronounced in a public hearing of the Committee on Science and Technology, Communication and Informatics of the National Congress, on September 26, 2013.

\(^{11}\) Itaipu is the biggest hydro plant in Brazil; it has an installed capacity of 14 GW and an annual production about 92 TWh/anno.
85% losses. It means that we need a generation equivalent to 9.3 Itaipus to deliver the necessary energy to move the fleet, a waste of 8 Itaipus. In comparison, with a fleet of electric vehicles the losses would be reduced to 2.1 Itaipus as well as the CO2 emission would be 36% lower.

The results above considered a country entirely supplied by thermoelectric power plants. If it were the case of a country entirely supplied by hydro plants, the gains in efficiency would be much higher. Instead of having 8 Itaipus losses, the waste of energy would be reduced to 0.23 Itaipus, and the emissions completely avoided.

**Figure 9 – Efficiency gains in countries with supply based on hydro plants**

*Source: Electric-Mobility Department of Itaipu Binacional*

Applying the reference value (Valor de Referência VR\(^\text{12}\)) over the wasted energy in the transportation sector, we reach a total amount of about R $75 billion. Just to have an idea of what those values represent, in 2015 the public budget provided R $91 billion to the Ministry of Health, R $39 billion to the Ministry of Education, R $17 billion to the Ministry of Defense and R $5 for the Ministry of Science and Technology. In addition, the country could also avoid the tens of billions of reais that are spent annually on the import of light oil and its derivatives (ca. R $67 billion in 2011).

We can say that the electric vehicles are machines of energy efficiency and energy conservation. Even if we consider the costs to build new power plants to supply the increase in electric energy consumption, it is worth. However, currently only a small share of the world fleet consists of electric vehicles.

\(^{12}\) The VR is a regulated price of electricity purchase costs by distribution companies. The calculation of VR takes into account the average value and the amount of contracts signed in previous auctions by utilities.
Over the last years, customers were concerned and doubtful about the new technology. People are unconfident about range limitations, reliable charging, also about buying something that is going to be obsolete due to fast technological change. Most of people are not aware about the implications above and have more immediate problems to solve or worry about in their lives. Even people that are more inclined to have a so-called “green lifestyle” are not unanimous about having an electric vehicle\textsuperscript{13}. Furthermore, the biggest problem is that consumers have cheaper and more reasonable alternatives to electric vehicles, despite the decreasing prices of electric cars.

To change this situation, the governments can stimulate the demand and the technological development itself. Some examples that summarizes the main policies (BARASSA, 2015) of demand-pull and technology-push are: intellectual property protection; standardization of components; government demand for new technologies; discount on fees and taxes in the acquisition of new technologies by consumers; subsidization of R&D; discount on fees and taxes for companies that invest in R&D; promotion of information exchange between agents; and sponsorship for education and professional training.

Nevertheless, it is not a simple task to influence the consumer’s choice. As pointed out in (BARASSA, 2015), even countries like Japan faced some difficulties when trying to incentive consumers to buy electrical cars.

Although the electric vehicles are still a small share of total global market, the sales are growing year by year. In countries like Norway, Netherlands, Iceland, Sweden, Denmark, Switzerland, France and United Kingdom, market share of electric vehicles sales was over 1\% in 2015, with a remarkable share of 22,39\% in Norway and 9,74\% in the Netherlands.

<table>
<thead>
<tr>
<th>Country</th>
<th>Market Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norway</td>
<td>22,39%</td>
</tr>
<tr>
<td>Netherlands</td>
<td>9,74</td>
</tr>
<tr>
<td>Iceland</td>
<td>2,93</td>
</tr>
<tr>
<td>Sweden</td>
<td>2,62</td>
</tr>
<tr>
<td>Denmark</td>
<td>2,29</td>
</tr>
<tr>
<td>Switzerland</td>
<td>1,98</td>
</tr>
<tr>
<td>France</td>
<td>1,19</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>1,07</td>
</tr>
<tr>
<td>Austria</td>
<td>0,90</td>
</tr>
<tr>
<td>China</td>
<td>0,84</td>
</tr>
</tbody>
</table>

*Source: https://en.wikipedia.org/wiki/Electric_car_use_by_country

\textsuperscript{13} http://www.sciencedirect.com/science/article/pii/S0965856414000500
The countries that participate of the Electric Vehicles Initiative\textsuperscript{14} (EVI) launched the target of having 20 million vehicles (battery or plug-in hybrid) until 2020. Nowadays EVI member countries hold the great majority of all world electric vehicle stock.

Table 4 and 5 shows this predominance of EVI country members. With the exception of Austria and Iceland in Table 4, all other countries are members of EVI. Much of this is due to policies that encompass financial supports in the form of taxes exemptions or reduction, rebates or credits in acquisition of efficient vehicles and investments in infrastructure and in R&D.

<table>
<thead>
<tr>
<th>Table 5 – Electric car stock in 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Country</strong></td>
</tr>
<tr>
<td>United States</td>
</tr>
<tr>
<td>China</td>
</tr>
<tr>
<td>Japan</td>
</tr>
<tr>
<td>Netherlands</td>
</tr>
<tr>
<td>Norway</td>
</tr>
<tr>
<td>France</td>
</tr>
<tr>
<td>United Kingdom</td>
</tr>
<tr>
<td>Germany</td>
</tr>
<tr>
<td>Canada</td>
</tr>
<tr>
<td>Sweden</td>
</tr>
<tr>
<td><strong>Global Total</strong></td>
</tr>
</tbody>
</table>

*Source: https://en.wikipedia.org/wiki/Electric_car_use_by_country*

A study released by Bloomberg New Energy Finance\textsuperscript{15} states that, by the year 2022, the electric vehicles are going to be cheaper to purchase and maintain than fossil fuels powered models. The analysis takes into account two things: future oil price and the decrease in the cost of lithium-ion batteries. The study claims that his prediction may be confirmed even if the "non-green" models increase their efficiency by 3,5% each year. Estimates indicate that 35% of new sales will be of electric vehicles by the year 2040, totaling 41 million vehicles. Sales could reach 50% if those models become common in fleets and car sharing companies. However, if the value of the oil barrel remains stable, the projection is lowered to 25%.

Graphic 20 shows the estimates done by Bloomberg New Energy Finance about the electric car sales increase. The point of liftoff for sales is predicted to happen between 2022 and 2028.

\textsuperscript{14} EVI is a multi-government policy forum dedicated to accelerating the introduction and adoption of electric vehicles worldwide. EVI currently includes 16 governments and the participation of IEA.

\textsuperscript{15} http://www.bloomberg.com/features/2016-ev-oil-crisis/
In Brazil, since 2014, licensing of hybrid and electric vehicles is over 800 units/anno, a derisory quantitative when compared to the average over 3 million cars and light commercial vehicles that are licensed in the country every year\textsuperscript{16}. Table 6 summarizes the main models of hybrid and electric vehicles commercialized in Brazil in 2015.

### Table 6 – Hybrid and electric vehicles commercialized in Brazil in 2015

<table>
<thead>
<tr>
<th>Vehicle size</th>
<th>Company</th>
<th>Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy</td>
<td>Eletra</td>
<td>Trólebus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Híbrido Br.</td>
</tr>
<tr>
<td></td>
<td>BYD</td>
<td>Ónibus Elétrico</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Byd Ebus</td>
</tr>
<tr>
<td>Light</td>
<td>Renault</td>
<td>Zoe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Twizy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kangoo</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fluence</td>
</tr>
<tr>
<td></td>
<td>Nissan</td>
<td>Leaf</td>
</tr>
<tr>
<td></td>
<td>Ford</td>
<td>Fusion</td>
</tr>
<tr>
<td></td>
<td>Toyota</td>
<td>Prius</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lexus CT 200h</td>
</tr>
<tr>
<td></td>
<td>BYD</td>
<td>BYD e6</td>
</tr>
<tr>
<td></td>
<td>BMW</td>
<td>I3</td>
</tr>
</tbody>
</table>

*Source: (BARASSA, 2015)

Public policies to stimulate the dissemination of hybrid and electric vehicles in Brazil are still very limited, but considering that almost all models commercialized need to be imported, the Federal Government made a significant step exempting the import tax

\textsuperscript{16} http://www.anfavea.com.br/tabelasnovo.html
rate of 35% for the electric vehicle models\textsuperscript{17}. This measure requires the vehicles to have an autonomy of at least 80 kilometers per full charge and benefits mantled, dismantled or semi dismantled units.

Regardless the exemption of the import tax, the tax system in Brazil is somewhat complex. The final price of vehicles is yet composed of other taxes and fees, at both Federal, State and Municipal level, what makes the imported vehicles quite expensive. Most of regular consumers would prefer to buy a bigger and more luxurious car instead of buying an expensive small car, even considering the benefits of fuel consumption efficiency in the long term.

Table 7 below shows the tax rates in 2014 for vehicles and wheel tractors manufactured and sold in Brazil.

\textbf{Table 7 – Taxes on vehicles and wheel tractors}

<table>
<thead>
<tr>
<th>ANO YEAR</th>
<th>TRIBUTOS / TAXES</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUTOMÓVEIS / CARS</td>
<td></td>
</tr>
<tr>
<td>2000 cm³</td>
<td></td>
</tr>
<tr>
<td>+ de 1000 cm³ a 2000 cm³</td>
<td></td>
</tr>
<tr>
<td>+ de 2000 cm³</td>
<td></td>
</tr>
<tr>
<td>COMÉRCIO LEVE</td>
<td></td>
</tr>
<tr>
<td>TRUCKS</td>
<td></td>
</tr>
<tr>
<td>CAMINHÕES</td>
<td></td>
</tr>
<tr>
<td>ONIBUS</td>
<td></td>
</tr>
<tr>
<td>TRACTORES DE RODAS</td>
<td></td>
</tr>
<tr>
<td>WHEEL TRACTORS</td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{*Source: ANFAVEA Yearbook 2015}

Graphic 21 below shows a comparison of the tax burden between Brazil and other countries with a large production and vehicle fleet. It clearly shows that the Brazilian tax burden is at a higher level.

\textbf{Graphic 21 – Tax burden on cars - Share in consumer prices - 2014}

\textsuperscript{(*) IPI rate basic. Gasoline powered cars from 1000 cm\textsuperscript{3} to 2000 cm\textsuperscript{3}. (**) California State. \textsuperscript{*Source: ANFAVEA Yearbook 2015}}

\textsuperscript{17} Resolução da Câmara de Comércio Exterior n\textsuperscript{°} 97/2015.
The numbers above apply for domestic production. Higher taxes and other fees may increase the final price when we consider an imported vehicle. Such a discrepancy, however, can configure an advantage in establishing incentive policies for electric vehicles. The current tax burden gives a considerable margin to alter the final prices paid by the consumer. A tax policy could reduce or nullify the difference between the electric vehicles and the conventional ones. According to ANFAVEA, net sales in 2013 were US$ 98,88 billion. From this value, we can have an idea about tax revenues provided by the automotive industry in Brazil.

Additionally, we have the values related to international trade summarized in Table 8, which encompass not only the vehicles itself, but also auto parts, agricultural machinery, highway construction equipment and other related products.

<table>
<thead>
<tr>
<th>US$ billion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Export</td>
</tr>
<tr>
<td>18,45</td>
</tr>
</tbody>
</table>

With smaller values and advantages, the States and Municipalities in Brazil also have enacted some laws and regulations that benefit consumers that buy hybrid or electric vehicles (i.e. Discounts or exemptions on fees, especial parking lots, and unrestricted days to drive). Those measures, however, are still shy because the consumers perceive the final prices and benefits as unattractive when compared to other options of conventional vehicles.

In Graphic 17 we saw that the perspectives of new car licensing in Brazil are pretty much optimistic about the hybrid models by the year 2040. On the other hand, by the year 2030, the market share amount is much lower than the global projections or the projections regarding the necessary amount to maintain the greenhouse gas emissions at an acceptable level.
As highlighted in the “Paris declaration & call to action” release, the effective contribution of electric transportation in the reduction of greenhouse gas emissions, to keep global warming below 2 °C, implies in a fleet of 100 million electric cars by the year 2030. To achieve this goal, IEA modelling says electric drive vehicles need to represent 35 percent of global sales in 2030. Although the good perspectives, it is still a big challenge, even if we consider the best scenarios. The study released by Bloomberg New Energy Finance, for example, state that the market share in sales will reach this amount much probably only by 2040. Along the way, new incentive mechanisms, financing options, business models and policies need to be implemented so that favorable conditions can be really potentiated.

In Brazil, the absence of domestic manufactured models and the final prices after import are the main barrier to disseminate the electric vehicles countrywide. For most individuals, the prices are high and doesn’t worth to wait for a long payback. On the other side, companies and government offices may have enough budget, better return rates, as well as other kinds of advantages, like marketing for being sustainable or environmentally friendly. Furthermore, Bloomberg New Energy Finance emphasized that the fleets and car sharing companies are important catalyzers to spread the technology.

Even with the exemption of the import tax, the prices are still high for most regular consumers. Because this, we advocate that benefit policies should be first focused on companies, public offices and governmental entities that use to have a corporate or official fleet. This measure may attenuate the decrease of tax revenue and the social cost of an eventual policy in the sense that:

i) Having an electric fleet, the private companies can be more efficient, decreasing fuel consumption and increasing their business, which in turns help the economy and increase tax revenues; and

ii) The cost of the official fleets is a burden for all citizens, who support through tariffs, fees and tax payment the budget of the government and its companies to maintain those fleets.

Beside the corporate and official fleets, all solutions regarding the electrification of public transportation could also be benefited with tax reduction policies. Such measures can increase both the domestic fleet of electric vehicles and the demand for equipment and auto parts related to the technology, which in turns develops the conditions to settle a domestic production at affordable prices for a larger share of the population. Over time, the depreciation of the corporate and official fleets could also start to supply the market of second-hand cars, allowing people to purchase those depreciated vehicles in another moment. This possibility, however, may give rise to negative externality if cars are deliberately sold before the lifetime end in the activity for which they were acquired. The policy has thus to consider some mechanism to prevent this behavior.

It is also important to emphasize here the different legal framework that private and public companies have to observe. Private companies may freely choose their suppliers and decide about the acquisition of equipment and materials. This is not the
case of public companies, which have to observe a specific law about this matter undertaking auctions and public calls whenever they want to contract services or buy anything for their activities. In the case of official fleets in public companies and offices, such a policy has additional importance because intangible benefits of the electric vehicles may not be considered in the reference value of the public auctions.

Finally, regarding the institutional role and the regulation that is under assignment of Agência Nacional de Energia Elétrica – ANEEL (National Electric Energy Agency), few but crucial points are left to be solved and discussed in policy maker’s level, among which we point out:

i) To define that the charging service is not an irregular supply of electric energy to third parties or a violation of the company’s distribution monopoly – It is essentially a service that can be offered at prices and conditions accordingly with the correlated commercial and antitrust legal framework, as well as building construction standards. Though obvious, it is a question that still brings uncertainties to entrepreneurs in Brazil;

ii) To define if the distribution companies will be allowed to offer the charging service as an accessory activity or even if they will be forbidden (or obligated) to do so – Depending on the chosen decision, this implies eventual changes in public concession contracts;

iii) To evaluate negative externalities regarding consumers that have subsidized tariffs and may use their installations to offer unduly charging services;

iv) To demystify the impacts that the electric cars will bring to the grid or the supply of electric energy – Both the vegetative growth of energy demand and the local impact of charging points pose no obstacle or technical difficulties for the electric energy sector or the distribution companies; and

v) To clarify the impact of possible legislative proposals on the subject – Some projects that are under discussion in National Congress may add unnecessary complexities with proposals of different tariffs, specific classification for charging points or even stipulating obligations to distribution companies about charging point infrastructure.

7 Conclusions

The Brazilian energy matrix is predominantly renewable, in a proportion (40%) much higher than the world average (13%). The import of energy resources is due to the need for oil and oil products to the transportation sector. The transportation sector is the second largest consumer of energy resources (28.2%), but these resources are non-renewable and heavily based on fossil fuels (82.8%). The electric energy matrix is predominantly based on hydroelectric power plants (65.2%). Regarding electric energy
consumption, the transportation sector is not a relevant consumer (0.3%). When we consider the energy segment, the transportation sector is the largest greenhouse gas emitter (46.3%). Emissions from light vehicles are particularly harmful in large urban areas, worsening healthy conditions or even bringing many peoples to death (8 million/ anno worldwide). The Brazilian cargo transport is predominantly based on roads (58%) and fossil fuels powered, which makes it more inefficient and expensive, reducing national competitiveness. In the long term, the transportation sector has the biggest energy efficiency gain potential (20% until 2050).

Electric vehicles are a feasible alternative to mitigate the problems arising from fuel combustion in the transportation sector. The concern about range limitation is an issue that affects the consumer’s choice about buying an electric vehicle. Nevertheless, most of the currently existing models are able to meet the daily displacement needs of most people. The final price of electric vehicles is still high and is the biggest barrier to the technology adoption. In Brazil, the high tax burden and the absence of domestic production imposes additional difficulties. Globally, electric vehicles represent only 1% of total stock, but annual sales growth is high (60%) and future prospects are positive. Studies indicate a possible replacement of fossil fuels powered cars in a few decades. According to EPE estimates, the domestic production of internal combustion powered cars will cease in the year 2045. So far, however, there is no domestic production of electric vehicles and the licensing of new vehicles is derisory (800 units/anno). Recently, the exemption of import tax for electric models was an important step to encourage sales. However, even with this measure, the final price remains high for most consumers.

Presenting the relevance of the transportation sector in the Brazilian energy matrix, as well as its implications for the environment and people’s health, this paper intends to contribute to the discussion of those questions. Presenting the advantages of electric vehicles in terms of energy efficiency, sustainability and environmental benefits, this paper also pursues to sensitize authorities about the opportunity to create policies to encourage the acquisition of electric vehicles. At first, we suggest that such policies could focus on the purchase of vehicles for corporate and official fleets, thus minimizing the social cost of the policy and encouraging efficiency gains in economic activities. Over time, the increased domestic fleet would also increase the demand for auto parts and services related to the new technology, improving the conditions to settle a domestic production.
References

ABRACICLO - Associação Brasileira dos Fabricantes de Motocicletas, Ciclomotores, Motonetas, Bicicletas e Similares (Brazilian Two Wheels Vehicles Industry Association).
<http://www.abraciclo.com.br/>

ABVE - Associação Brasileira do Veículo Elétrico (Brazilian Electric Vehicle Association).
< http://www.abve.org.br/>

ANFAVEA - Associação Nacional dos Fabricantes de Veículos Automotores (Brazilian Automotive Industry Association).
<http://www.anfavea.com.br/>


Bloomberg New Energy Finance. Here’s How Electric Cars Will Cause the Next Oil Crisis.  

Cars and motorcycles per capita in Brazilian Municipalities. 
<http://g1.globo.com/carros/frota-carros-motos-2013/index.html>

Clean Energy Ministerial. 
<http://www.cleanenergyministerial.org/>

Deaths caused by air pollution according to WHO. 
<http://g1.globo.com/jornal-nacional/noticia/2015/06/oms-diz-que-poluicao-atmosferica-mata-oito-milhoes-de- pessoas-por-ano.html>

EPE - Empresa de Pesquisa Energética (Energy Research Company). 
<http://www.epe.gov.br/>

IEA - International Energy Agency. 
<http://www.iea.org/>

Itaipu Binacional. 
<https://www.itaipu.gov.br/>


Matriz Energética Nacional (National Energy Matrix).  

MME - Ministério de Minas e Energia (Minestry of Mines and Energy).  
<http://www.mme.gov.br/>

Nota Técnica DEA 13/14 – Demanda de Energia 2050.  

Observatório do Clima (Climate Observatory).  
<http://www.observatoriodoclima.eco.br/>

SEEG - Sistema de Estimativas de Emissões de Gases de Efeito Estufa (Greenhouse Gas Emissions Estimates System).  
<http://seeg.eco.br/>